IS 7743 (2006): Recommended practice for magnetic particle testing and inspection of steel forgings [MTD 21: Non-Destructive Testing]

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भारतीय मानक

चुम्बकीय कण परीक्षण और इस्पात गढाई के निरीक्षण की अनुशंसित रीति

(पहला पुनरीक्षण)

Indian Standard

RECOMMENDED PRACTICE FOR MAGNETIC PARTICLE TESTING AND INSPECTION OF STEEL FORGINGS

(First Revision)

ICS 19.100; 77.140.85

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 3

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Non-destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1975. This standard is intended to be a guide for the manufacturers, inspecting authorities and purchaser to apply approximate techniques for detecting flaws in ferromagnetic steel forgings. This has now been revised in the light of experience gained in this field.

In this revision, the following modifications have been carried out:

a) Scope has been modified by including total length of linear discontinuities in the unit area;
b) Reference clause has been included;
c) Requirements of testing personnel (*see* **4**) has been included;
d) Requirements of surface condition and test equipment have been modified;
e) Requirements of magnetic inks (*see* **7.4** and **7.5**) have been included;
f) Requirements of longitudinal magnetization (*see* **8.1**), circular magnetization (*see* **8.2**), yoke method (*see* **8.3**) and local circular magnetization or prod magnetization (*see* **8.4**) and continuous method (*see* **10.2**) have been modified by including figures; and
g) Requirements of inspection for non-fluorescent inks have been included.

This standard is to be read in conjunction with IS 3703 : 2004 'Code of practice for magnetic particle flaw detection (*second revision*)'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

RECOMMENDED PRACTICE FOR MAGNETIC PARTICLE TESTING AND INSPECTION OF STEEL FORGINGS

(First Revision)

1 SCOPE

1.1 This standard describes the procedure for magnetic particle testing and inspection of ferromagnetic steel forgings.

1.2 Magnetic particle testing provides for the detection of cracks and other discontinuities situated at or near the surface in ferromagnetic materials. The sensitivity of the test is maximum for surface discontinuities and diminishes rapidly with depth below the surface.

1.3 This standard does not stipulate any requirement for the acceptance or rejection of forgings on which flaws have been revealed. This shall be subject to mutual agreement between the contracting parties. This agreement may include the following:

a) A statement specifying that the forgings shall be subjected to magnetic particle testing and inspection in accordance with the standard together with any additional requirements considered necessary;
b) Locations on the forgings which are subjected to magnetic particle testing and inspection;
c) Stage of manufacture at which the test is to be conducted, the technique to be used and the magnetizing field or current strength to be employed;
d) Type of discontinuities to be considered undesirable; and
e) Total length of linear discontinuities in unit area shall be reported.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
3415 : 1998	Glossary of terms used in magnetic particle flaw detection (*second revision*)
3703 : 2004	Code of practice for magnetic particle flaw detection (*second revision*)
6410 : 1991	Magnetic flaw detection inks and powders (*first revision*)
13805 : 2004	General standard for qualification and certification of non-destructive testing personnel (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 3415 shall apply.

4 PERSONNEL REQUIREMENTS

Personnel conducting the test in accordance with this practice shall be qualified and certified as per IS 13805.

5 SURFACE CONDITION

5.1 The surface condition of the forging or those parts under examination shall be such that there is no interference with the test. All areas to be examined shall be free from heavy scale, dirt, grease, paint or any other foreign matter, which may interfere with the application to test.

5.2 The methods used for cleaning and preparing the surfaces for magnetic particle inspection shall not be detrimental to the material and surface finish of the forgings or to the tested materials.

5.3 The part shall be demagnetized before examination, if prior operations have produced a residual magnetic field that may interfere with the examination.

5.4 Magnetic particle examination shall not be performed with non-conductive coatings.

6 TESTING EQUIPMENT

6.1 The testing equipment shall be capable of inducing an adequate magnetic flux in the forging or area of forging under test. Suitable equipment shall be provided to ensure that the required field strength is obtained. If current flow machines are employed, an ammeter shall be incorporated in the output circuit. The ammeter shall have a scale length of 60 mm or greater, and shall comply with accuracy of ±5 percent. The nominal wave form of energizing current shall be shown on the apparatus. Together with the manner in which the current is indicated by the meter of the equipment, for example, peak, r.m.s. mean.

6.2 The high-amperage, low-voltage current required in the magnetic testing of forgings may be obtained from alternating current source, full or half-wave rectifiers, a storage battery or a motor generator set.

6.3 The apparatus and the ancillary equipment shall be checked at least once in three months by a competent person/agency to ensure its continuing efficacy. A record of the check shall be kept.

6.4 A functional test shall be carried out by the operator before commencing work. The test shall be designed to ensure the proper functioning of both the equipment and magnetic medium.

7 INSPECTION MEDIA

7.1 General

For the purpose of this standard, testing materials are classified in the following groups:

a) *Group* 1 — Dry powders, in which the magnetic particles are applied without the use of a carrier fluid.

b) *Group* 2 — Magnetic flaw detection inks consisting essentially of magnetic particles in a carrier fluid.

c) *Group* 3 — Fluorescent magnetic inks consisting of magnetic particles and fluorescent materials in a carrier fluid, used in conjunction with black light.

7.2 The testing materials described in **7.1** shall comply with IS 6410.

NOTE — Different carrier fluids may be used in conjunction with Group 2 materials and contrast aids may be employed with Group 1 and Group 2 materials.

7.3 Magnetic Inks (Group 2 and Group 3)

Magnetic inks shall be checked at frequent intervals of two days, if in continuous use in order to ensure that the suspension satisfies the requirement of IS 6410. Air from a compressor should not be used for agitation because of introduction of moisture and the creation of fumes. The magnetic inks shall be discarded and replaced when it become discoloured by oil, contaminated by any foreign substance or has otherwise deteriorated to the extent that proper distribution and concentration of the suspension on the intensity, character or definition of the deposits of the magnetic particles is affected.

7.4 Magnetic inks shall not be mixed unless they are of the same type and specification and are supplied by the same manufacturer.

7.5 The performance of fluorescent magnetic inks used in a system where it is re-circulated (that is, pumped) shall be assessed weekly by comparing its performance in revealing known flaws with the performance of fresh sample of inks.

NOTE — Bath should be stirred well to bring the settled fluorescent magnetic powder, if any into suspension prior to carrying out MPI test.

8 METHODS OF MAGNETIZATION

The entire forgings or specific areas on the forging to be tested shall, where practicable, be magnetized successively in two mutually perpendicular directions. The best results are obtained when the magnetic field is at right angle to the discontinuity being examined.

8.1 Longitudinal Magnetization

When a forging is magnetized longitudinally, the magnetic flux lines are usually parallel to the axis of the piece. Longitudinal magnetization may be accomplished by placing the forging within a solenoid, often formed by wrapping a flexible cable around the piece. The forging may also be magnetized by making it a link in a magnetic circuit or by placing it in a magnetic field created by a strong permanent magnet or electromagnet (*see* Fig. 1).

8.2 Circular Magnetization

Circular magnetization is obtained by passing current directly through the forging. In the case of a hollow forging, circular magnetization may be obtained by passing the current through a conductor or bar placed through a central opening in the forging (*see* Fig. 2).

8.3 Yoke Method

This method should be used only to detect discontinuities which actually open to the surface. Alternating current electromagnetic yokes may be used to magnetize, provided the yoke has a lifting power of at least 4.5 kg and a pole spacing of 75 to 150 mm. Direct current electromagnets or permanent magnetic yokes may be used to magnetize, provided the yoke has a lifting power of at least 18 kg and pole spacing of 75 to 150 mm (*see* Fig. 3).

NOTE — Except for materials 6 mm or less in least dimension, alternating current yokes are superior to direct current or permanent magnet yokes of equal lifting power for the detection of surface cracks.

8.4 Local Circular Magnetization or Prod Magnetization

When the forging is too large to be magnetized as a whole, it may be magnetized locally by passing current through areas or sections by means of contracts or prods. The magnetizing current should not be turned on until after the prods have been properly positioned in contact with the surface and the current should be turned off before the prods are removed (*see* Fig. 4).

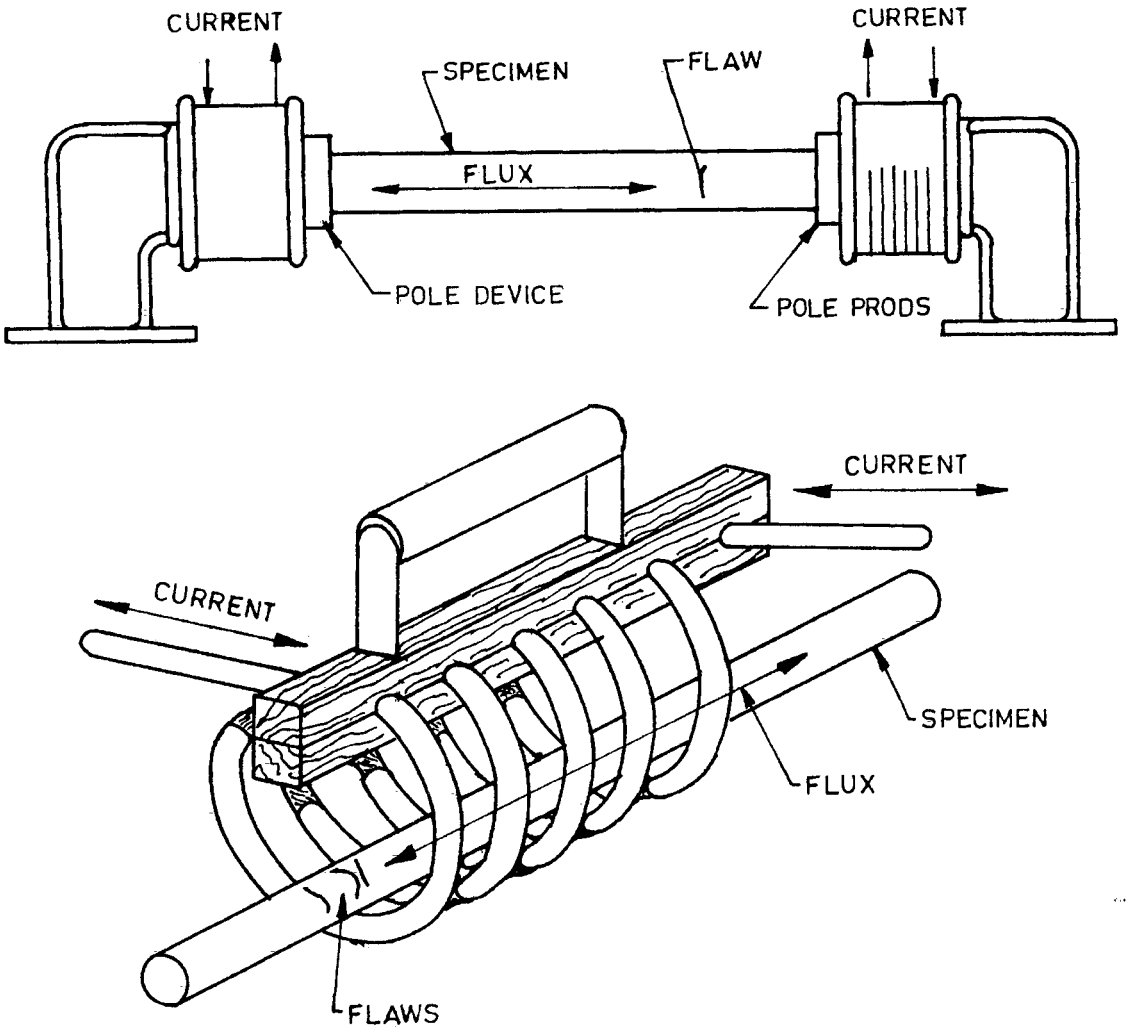


FIG. 1 LONGITUDINAL MAGNETIZATION

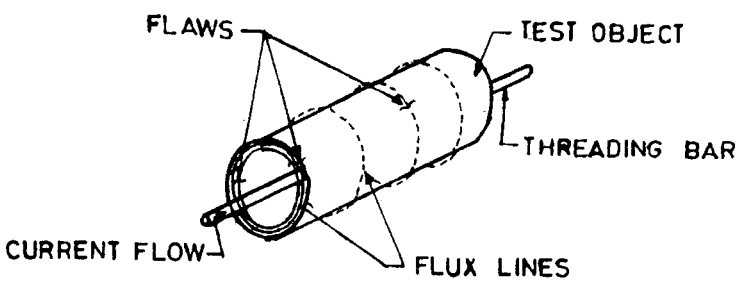


FIG. 2 CIRCULAR MAGNETIZATION

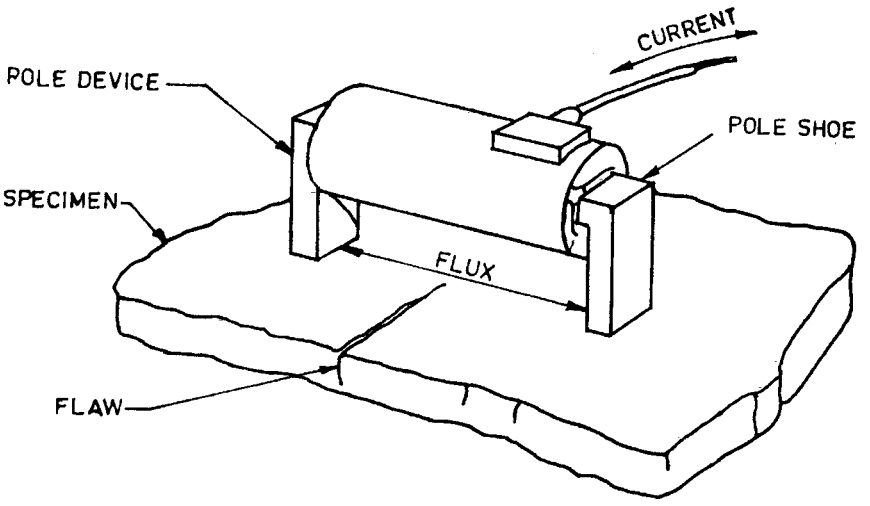


FIG. 3 YOKE METHOD

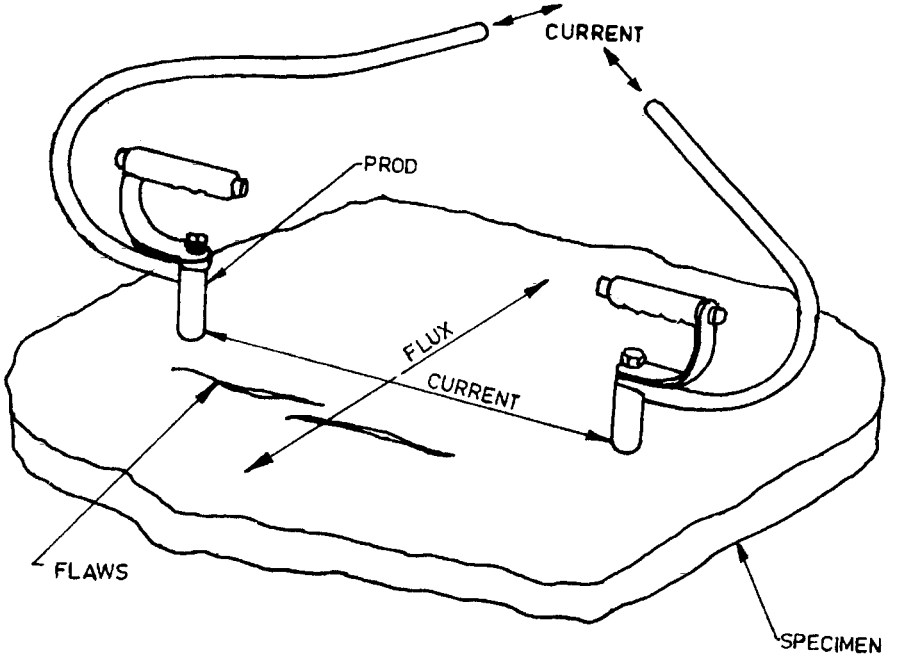


FIG. 4 LOCAL CIRCULAR MAGNETIZATION OR PROD MAGNETIZATION

9 MAGNETIZING FORCE

9.1 The minimum field strength which will reveal and permit classification of all objectionable defects shall be used. The maximum field strengths practicable are the ones just below the point at which excessive adherence of the particles begins to occur over the surface being inspected.

9.2 Suitable instruments shall be provided to maintain the magnetizing force within the agreed limits.

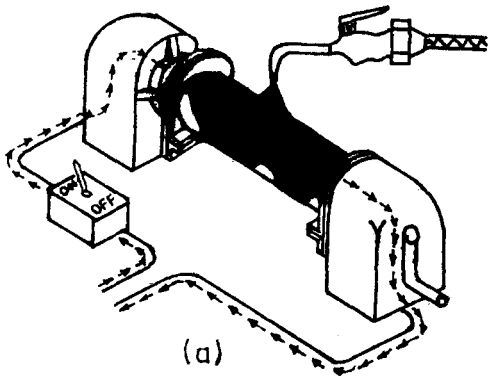
9.3 As a general guidance, the magnetizing force or current indicated in IS 3703 can be employed.

10 APPLICATION OF MAGNETIC PARTICLES

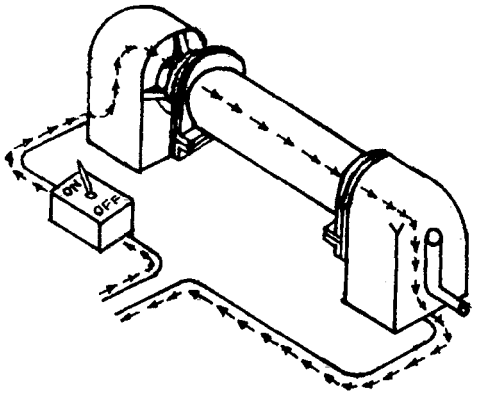
10.1 The surface to be examined shall be adequately and uniformly coated with the magnetic particles. The coating may be applied by immersion, flooding or spraying. The magnetizing current shall be applied at least twice, either by the continuous or residual methods, the sufficient time shall be allowed for indications to build-up.

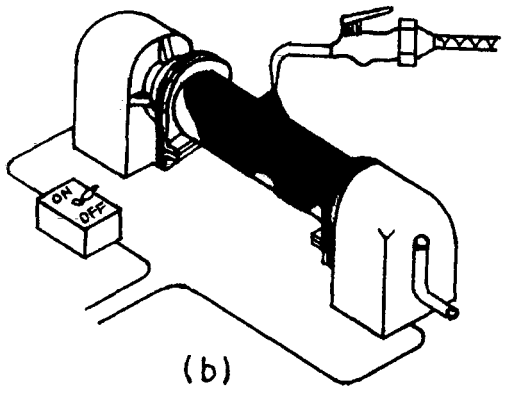
10.2 Continuous Method

Wherever possible, this method, in which the testing materials are applied while magnetizing continuously, shall be employed. Care shall be taken to ensure that particle patterns are not disturbed after magnetization has been stopped and before the particle patterns have been inspected and recorded. The colour of the particles should be chosen to provide suitable contract (*see* Fig. 5).



5A Flow of MPI Suspension During Electric Current Flow





5B Flow of MPI Suspension After Electric Current Flow

FIG. 5 CONTINUOUS METHOD

10.3 Residual Method

In this method, the testing material is applied to the surface under inspection after the forging has been magnetized. The effectiveness of this depends upon the strength of the magnetizing force and the retentively of the material of the forging. This method shall only be used in those cases where the continuous method can not be employed. If the residual method is used, it is recommended that direct current only be employed for magnetization purpose and the value of current applied shall be agreed to between the interested parties.

11 INSPECTION

11.1 Visual examination of the magnetic particle pattern on the forging surface shall be made under appropriate viewing conditions. Flaws shall be indicated by a build-up of magnetic particles when using Groups 1 and 2 testing materials, or by fluorescent indications when using Group 3 materials. If required, a permanent record of the flaws may be obtained. A low powered magnifier is a desirable inspection aid, particularly when very small flaws are to be inspected. Defects found on inspection and requiring repair or investigation should be marked out clearly using grease pencil, or coloured crayon or paint.

11.2 When using non-fluorescent inks and powders there shall be good contrast between the detecting medium and the component being inspected and the area under inspection shall be evenly illuminated at a level of not less than 500 lx (lux) daylight or artificial light. This would be achieved by using either a fluorescent tube of 80 W at a distance of about 1m, or a tungsten filament lamp of 100 W at a distance of about 0.2 m.

12 DEMAGNETIZATION

12.1 Some parts will retain an appreciable magnetic field after inspection. This does not affect the mechanical properties of the piece and, in many cases, will not be detrimental to subsequent usage. In some cases, however, it may be necessary to demagnetize the part. If, for example, the part is to be subsequently machined, a residual field may cause chips to collect on the tool. If the part is to be used in locations near sensitive instruments, high residual field might affect the operation of the instruments. Demagnetization shall be required only, if specially called for in drawings, specifications, or purchase orders. In all cases, the field strength used to demagnetize shall be equal to, or greater than, the field which was used to magnetize the part. The usual techniques of demagnetizing are as follows.

12.1.1 The method most widely used is to withdraw the part from the field of a high-intensity alternating-current coil. A field strength of 5 000 to 10 000 amphere-turns is recommended. Care should be exercised that the part is entirely removed from the influence of the coil before the demagnetizing force is discontinued, otherwise the demagnetizer will have the effect of magnetizing the part.

12.1.2 The alternating-current magnetizing force may be reduced in small decrements down to a negligible value. This usually requires special equipment which permits the current to be reduced in 25 or more small decrements.

12.1.3 Consecutive steps of reversed and reduced direct current magnetization may be used, down to a negligible value. This is the most effective method of demagnetizing large parts in which the alternating-current field has insufficient penetration to remove the residual magnetism. This method requires special equipment for reversing the current and simultaneously reducing it in 25 or more small decrements.

13 INTERPRETATION OF RESULTS

13.1 All indications revealed by magnetic particles during magnetic particle inspection do not necessarily represent flaws since spurious indications may also be encountered. Some typical examples of false indications are given in IS 3703.

13.2 Indications believed to be non-relevant shall be explored by visual methods and if necessary the test surface shall be cleaned and re-tested by the appropriate procedure.

13.3 Relevant indications shall be evaluated in accordance with the criteria acceptance agreed between the parties concerned.

14 PRESENTATION OF DATA

The following information shall be included in the report of a magnetic particle test:

Report Sheet: Magnetic Particle Flaw Detection

a) Name and address of the company,
b) Location,
c) Description and identity of component/part used,
d) Date of test,
e) Stage of test,
f) Description of equipment used,
g) Detecting medium, background and viewing conditions,
h) Methods of flux generation,
j) Distance between contact areas,
k) a.c/d.c./half-wave/full-wave rectified,
m) Maximum/minimum Ampere (A),
n) Surface preparation,
p) Method of recording/marking indications,
q) Demagnetization,
r) Reasons for test,
s) Previous history,
t) Results of tests, and
u) Name and signature of person conducting test.

15 CLEANING

After testing and acceptance, all components shall be cleaned to remove all traces of detecting media.

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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Amendments Issued Since Publication

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